

**CONVENTIONAL OIL AND GAS, GATHERING AND PROCESSING
SYSTEMS AND FACILITIES**

Prepared for:

**Economic Development Branch
BC Ministry of Sustainable Resource Management**

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Prepared by:

Tamarack Solutions Inc.

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BUILDING BLOCKS FOR ECONOMIC DEVELOPMENT & ANALYSIS

PREFACE

PURPOSE

Building Blocks have been conceived and developed by the Economic Development Branch of the Ministry of Sustainable Resource Management, under the guidance of Nancy South, Manager Economic Analysis, as an analytical tool that supports British Columbia coastal and land and resource use planning and decision-making and economic development initiatives. The Blocks contain concise business and sector information for a broad range of resource-based business types in BC. At this point, there are more than 30 Blocks either complete or in draft form. Several more Blocks have been identified as high priority by planning tables and other client groups. Additional Building Blocks will be developed over time, and some Blocks may be updated. For the most current Building Blocks, please see the Ministry of Sustainable Resource Management website, at: <http://srmwww.gov.bc.ca/rmd/ecdev/>

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BENEFITS

Building Blocks are expected to provide the following general benefits:

- Increase efficiency and more informed decision-making by providing readily accessible, credible information to planning and economic development processes;
- Improve the consistency of economic information across planning areas;
- Support economic analysis and decision-making that occurs outside formal coastal and land use planning processes; and
- Provide linkages between economic analysis and other social and environmental analytical tools (through identifying resource requirements to support economic activities and general compatibilities with other sectors and values).

LIMITATIONS

Every effort has been made to ensure that the information contained in Building Blocks is accurate and consistent. Approved, credible data sources are the foundation for Building Blocks. All Blocks were reviewed by sponsoring agencies and other experts. However, users are cautioned that information is used at their own risk, and that the authors and sponsors are not liable for any damages. Any conclusions or interpretations by the authors are not intended to represent government policy. Also, note that Building Blocks do not provide site specific information nor do they consider requirements for sustainability (social, community, environmental).

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TABLE OF CONTENTS

1.0	OVERVIEW.....	1
1.1	DESCRIPTION	1
1.2	INDUSTRY COMPONENTS	1
1.3	GATHERING AND PROCESSING SYSTEMS AND FACILITIES - DETAILS.....	3
2.0	LAND RESOURCE REQUIREMENTS/SENSITIVITIES.....	4
2.1	PROVINCIAL CROWN AND OTHER RESOURCES REQUIRED TO SUPPORT BUSINESS.....	4
2.2	COMPLEMENTARY/CONFLICTING RELATIONSHIPS WITH OTHER RESOURCE VALUES	4
3.0	INVESTMENT REQUIREMENTS.....	5
3.1	CAPITAL (START-UP) COSTS.....	5
3.2	OPERATING (ONGOING) COSTS.....	7
3.3	FUTURE CAPITAL COSTS	7
4.0	INFRASTRUCTURE	8
4.1	OVERVIEW	8
5.0	MARKET	9
6.0	LABOUR FORCE	9
7.0	CAPACITY	11
8.0	REGULATORY REGIME.....	11
8.1	OVERVIEW	11
8.2	PROVINCIAL.....	12
8.3	FEDERAL GOVERNMENT	13
8.4	TIMING	14
9.0	GOVERNMENT REVENUES	14
9.1	MUNICIPAL.....	15
9.2	PROVINCIAL.....	15
9.3	CROWN ROYALTIES	16
9.4	FEDERAL.....	16
10.0	INPUT-OUTPUT TABLE.....	17
11.0	REGIONAL COST VARIATIONS	17
11.1	REGIONS	17
11.2	REGIONAL DATA.....	18
11.3	PRE-TENURE PLANNING.....	18
11.4	EVOLUTION OF IMMATURE BASINS TO MATURE PRODUCING REGIONS.....	18
11.5	OPPORTUNITIES.....	19
11.6	CHALLENGES.....	19
	REFERENCES.....	20

1.0 OVERVIEW

1.1 Description

British Columbia is the second largest natural gas producing province in Canada and accounts for 13% of Canada's production. Most petroleum activity takes place in the northeastern section of the province. Large, world-class natural gas discoveries have focused significant interest in this area. Industry expenditures in British Columbia reached \$4.3 billion and a record number of wells (850) were drilled in 2001. Crude oil and condensate production, and natural gas production in 2001 were $2687 \times 10^3 \text{ m}^3$ and $29.9 \times 10^9 \text{ m}^3$, respectively. The sales value of this production was around \$5.6 billion. Direct revenues from royalties and oil and gas rights were \$1.7 billion.

1.2 Industry Components

The exploration and development of oil and gas is a capital-intensive process that from the onset is focused on producing hydrocarbons to a sales point in the shortest and most profitable manner. Following is a description of exploration and development elements and decision processes. Information related to the maturing and production of resource basins can be found in the Appendix.

Wide Area Geological Review (conducted in corporate head offices, normally located in Calgary or foreign countries):

- Publicly available geological and geophysical data and information from data vendors are investigated. Seismic data can be purchased from data vendors in a raw or processed form.
- Geologists and geophysicists begin by researching data made available by governments.
- Government data includes subsurface electronic well logs, drilling reports and oil and gas production reports.

Acquiring Oil and Gas Rights - Proposals and Decisions (typically made in Calgary; some decisions include review by foreign offices):

- A company will usually participate in a tenure competition with other partners. Companies seek out partners to reduce their risk.
- Companies bid on the basis of their wide area geologic review. The level of bonus paid is dependent on the estimated quantity of gas or oil, the cost and timing to drill a well, the royalty and taxes payable to the Crown, the proximity to a pipeline and plant infrastructure, and the expected price that can be realized at the nearest sales point. This information is processed in economic models that assist in determining the level of bonus paid to the Crown.

The following three activities all require surface land access, through agreements with the Crown or landowner, in the case of private land.

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Geophysical Exploration (decisions on geophysical contracts and programs are usually made in Calgary):

- Geophysical technology greatly reduces the risk of drilling. Wells are drilled to test a geological theory or model that is generated in the Wide Area Geological Review and validated by seismic data. The relative position of rock layers can be imaged from the patterns of acoustic sound waves that are reflected from subsurface formations.
- For two-dimensional (2D) seismic operations, field crews run parallel lines of sound recorders at wide intervals to cover large areas in a relatively inexpensive manner.
- Once a field is discovered, 3D seismic can be run in a grid pattern with close sound recorders to delineate the most attractive places to drill additional wells and determine the areal extent of a formation.

Drilling (drilling contractor selection may be done in Calgary; supervision in Fort St. John):

- Initial activities are road, site and well location surveying, followed by road and lease clearing, grading and applying gravel.
- The drilling rig is moved on site and crews work 24 hours a day to drill a hole ranging in depth from about 1000 metres to 3000 metres.
- Once the hole has been drilled to the target formation, the well is logged with electronic downhole measurement tools to record the characteristics of the subsurface rock formations.
- If logging indicates the well is productive, it is cased with steel pipe and a wellhead of shutoff valves is installed to prepare for production. The well is completed by perforating holes in the casing at the depth of the producing formation.

Gathering and Processing Systems and Facilities (designing is typically done in Calgary; project management and decisions on contracts can be made at regional offices such as Fort St. John):

- Pipeline connections to gas wells are necessary linkages to gas processing plants and wide-area transmission lines. Oil wells are typically connected by pipelines to treating facilities. Oil can be trucked from remote or low productivity wells that do not economically support pipelines.
- Gas plants remove sour gas (hydrogen sulphide [H_2S]), carbon dioxide, nitrogen and water from raw gas.
- Oil facilities, typically called oil batteries, remove natural gas and water from the oil stream prior to transport via oil transmission lines.

Abandonment and Reclamation

After wells are shut in, well casings are sealed and cut off below surface to abandon the wells. Surface sites and pipeline rights-of-way are reclaimed. Pipelines are abandoned by displacing hydrocarbons, filling the pipe with inhibited water and cutting off surface risers. Eventually wellsites, cut lines and roads are returned to a state that can sustain native vegetation.

The information presented above describes what is known as the "upstream sector" of the oil and gas industry. The midstream and downstream sectors, which are beyond the scope of the Conventional Oil and Gas building blocks, are described below.

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Midstream Sector

This sector consists of pipeline systems that connect producing and consuming areas. Other midstream facilities extract sulphur and natural gas liquids (NGLs), store products, and transport products by truck, rail or tanker. Gas transported via major transmission pipelines is typically comprised of methane and ethane. (Propane, butane and other NGLs are removed and stored before entering a gas transmission line.)

Downstream Sector

This sector consists of refineries, gas distribution utilities, oil product wholesalers, service stations and petrochemical companies.

1.3 Gathering and Processing Systems and Facilities - Details

This building block addresses gathering and processing systems and facilities. Building blocks that address geophysical exploration, and tenure acquisition and drilling have also been developed. Production revenue has been captured in this building block.

Most crude oil and natural gas production requires some treatment to remove undesirable components before the commodity goes to market. Treatment facilities can range from settling tanks that remove sediment and water, to billion-dollar plants that remove sour (hydrogen sulphide [H₂S]) gas, carbon dioxide, nitrogen and water, and separate out major products, including condensate, natural gas liquids (NGLs) and sulphur. Gas-gathering and transmission lines are required to transport raw gas to processing plants and marketable gas to other transmission lines and customers. Crude oil and NGLs are collected by main gathering systems and transported to refineries for processing.

Industry Structure and Activity

- Facilities (i.e., producer-owned plants) are generally located as close as possible to production sites. Three major plants at Taylor, Fort Nelson and Pine River draw from large areas and are far away from many producing fields.
- Oil refineries are located in Alberta, B.C. and Washington.
- The majority of facility and pipeline construction companies and operators are in oil industry towns; Fort St. John is the predominant location in British Columbia.
- Most oilfield materials and equipment are manufactured outside of B.C.

Primary Activities

- Rights-of-way and Site Preparation
 - surveying and clearing of pipelines right-of-ways, access road and facility sites (existing roads used where possible)
 - improving existing roads where required
- Gas Treatment
 - collecting gas from wells via gathering systems to central facilities and gas processing plants
 - installing lineheaters or dehydrators at wells to prevent freezing and condensation during transport

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- installing compressors in field locations to maintain pressure for transport and acceptance to plants
- building gas plants to remove liquids, acid gases (including carbon dioxide and H₂S) and water
- installing sulphur recovery facilities if the sulphur inlet rate is above a specified threshold
- Compressing and transporting gas to downstream transmission lines and customers Oil Treatment
 - collecting oil from wells via gathering systems
 - installing separators and treaters to remove gas and water from oil at wellsite or central battery
 - collecting and transporting of oil to refineries via main gathering systems and transmission lines

2.0 LAND RESOURCE REQUIREMENTS/SENSITIVITIES

2.1 Provincial Crown and Other Resources Required to Support Business

- sub-surface tenure under the *Petroleum and Natural Gas (P&NG) Act*
- surface rights (under the Land Act or from the landowner)
- efficient, cost-effective access
- Provincial forest
- rangeland
- designated land use areas
- Agricultural Land Reserve
- aggregates for lease and road construction

2.2 Complementary/Conflicting Relationships with Other Resource Values

Although pipeline and facility construction and operations may affect other resources, application review processes that take into consideration other resource values have been put in place to minimize or mitigate potential effects. Following are lists of issues that are addressed before these activities can proceed:

Complementary Relationships

- Pipeline rights-of-way and access roads can provide wildlife corridors and new access for recreation users and guide outfitters, trappers, residents, and communities.
- New access can increase the potential for forest, mineral and utility development and tourism.

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Possible Resource Conflicts

- Archaeological Sites – Improper route selection can cause disturbance to archaeological sites and heritage resources, including heritage rivers.
- Ecosystems – The area may be impacted by alteration of drainage patterns, disturbance to native vegetation, surface disturbance and erosion, and the introduction of noxious weed species.
- First Nations – Activities may affect historical and current uses (e.g., spiritual, gathering and hunting sites) and/or areas used to exercise treaty or aboriginal rights. Companies and First Nations may enter discussions to identify ways to avoid or mitigate impacts.
- Fish – Alteration of drainage patterns and erosion can impact watercourses and destroy fish or fish habitat.
- Forestry – The clearing of rights-of-way can result in a loss of timber resources, particularly if the timber quantity is uneconomic to recover.
- Water – Improper facility operations may result in product releases into surface and groundwater, causing contamination.
- Wilderness – Wilderness values for areas, currently accessible only on foot or horseback, can be lost once new access and rights-of-way have been introduced.
- Wildlife – The clearing of rights-of-way, surface facility sites and access roads can alter and fragment habitat, and create access and linear sight-lines, increasing the potential for adverse impacts on wildlife populations, particularly during sensitive breeding, rearing or wintering periods.

Other Issues

- In addition to the potential resource conflicts listed above, pipeline crews and plant and other surface facility operators must take precautions to control flaring, properly dispose of facility and camp wastes, and avoid releases of sour gas and high vapour pressure (HVP) products.

3.0 INVESTMENT REQUIREMENTS

3.1 Capital (Start-up) Costs

Expenditures on field equipment in British Columbia mirror drilling expenditures, which depend on a variety of factors, including commodity prices, the investment environment and corporate priorities. In the 10-year period from 1991 to 2000, the range was from \$92 to 375 million, with the peak occurring in 2000. However, expenditures on gas plants have varied widely, from a low of \$27 million, to highs of \$300 and 270 million in 1994 and 1997, respectively. This is because plant developments require longer-term planning and the need for new plants depends on the proximity of developments to the existing infrastructure and market conditions.

Wellsite equipment costs for oil wells are addressed in the building block for tenure acquisitions and drilling. Facility costs depend on the capacity and type of equipment, the H₂S concentration of the gas and, in the case of pipelines, location and length. Typical gas

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gathering system investments are listed below; costs include installation. (These costs are presented in Imperial units, which are the standard, particularly when dealing in North American markets.)

Line heaters are often located at wells to keep the gas temperature high enough to avoid hydrate blockages (caused by the combination of hydrocarbon liquids, free water and low gas temperatures) in pipelines. Dehydrators are used to remove water prior to transporting gas in a gathering system or transmission pipeline. Compressors are required if the reservoir pressure and therefore gathering system pressures are below that of a minimum gas plant inlet pressure. Compression is also required to boost the pressure of a well or group of wells to permit flow into a higher-pressure pipeline flowing to the plant inlet.

- Lineheaters – prices are approximate for units with capacity up to 10,000 mscf/d (280 10⁶m³/d)
 - single pass, low pressure - \$120,000 (sour service - \$200,000)
 - double pass, high pressure - \$200,000 (sour service - \$400,000)
- Dehydrators – prices are approximate for glycol units with capacity up to 10,000 mscf/d (280 10⁶m³/d)
 - \$300,000 to 400,000 (sour service - \$500,000)
- Compressors – prices are approximate for gas driven units
 - reciprocating, 200 to 1000 bhp - \$800,000 to 2.5 million (sour service - \$1 to 3 million)
 - centrifugal 1200 bhp - \$3 million (sour service - \$3.5)

Pipelines (gathering and sales) – unit costs for lines decrease as pipeline length increases

Region	2 km (\$/dia.in.m)*	14 km (\$/dia.in.m)
Plains-FSJ	44	36
Deep Basin	45	38
Fort Nelson	42	35
Foothills (S)	60	50
Foothills (N)	55	45

* \$/nominal diameter in inches/metre

Gas Processing Plants – Gas plant costs vary widely depending on the location, design capacity, type of gas (i.e., sour, liquids content) and process. Costs can range from \$1million for a small plant for sweet, relatively dry gas, to well over \$50 million for a relatively large, sour plant (e.g., 40,000 mscf/d). A significant portion of gas produced in B.C. is processed in plants owned by Duke Energy Gas Transmission (formerly Westcoast Energy Inc. plants). If a company does not own and operate it's own plant, it uses "third-party" processing offered by a company such as Duke Energy. In some cases, upstream third-party gathering systems and compression are also used. Companies pay tolls for these services. (See Operating Costs for information regarding tolls.)

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Transmission – Gas is transported to markets (and downstream transmission systems) via the Alliance, TransCanada and Duke Energy pipeline systems. (Oil is transported to Alberta, B.C. and Washington area refineries via the Pembina Pipeline and Transmountain systems.) See Operating Costs for information regarding tolls.

3.2 Operating (Ongoing) Costs

Duke Energy recovers its investment and operating costs for gathering and processing raw gas through tolls. These costs (and equivalent costs for producer-owned facilities) are summarized in the following table.

Region	Gathering/Operating Cost (\$/mcf)	Processing (\$/mcf)
Plains-FSJ	0.25 – 1.03	0.18 – 0.60
Deep Basin	0.43	0.22
Fort Nelson	0.46 – 0.54	0.40 – 0.64
Foothills (S)	0.50	1.24
Foothills (N)	0.67	0.44

Transmission tolls vary depending on whether the service is firm or interruptible, the length of system utilized and the transmission service area. The three major Raw Gas Transmission Service areas for Duke Energy and the associated tolls as of September 1, 2002, are listed below, to illustrate toll ranges. (Interruptible commodity charges are in the range of 0.313 to 13.019 $\$/10^3\text{m}^3$.)

Firm Transportation Tolls	Demand Toll Range (\$/ 10^3m^3 /mth)	Commodity Toll Range (\$/ 10^3m^3)
Fort Nelson (Fort Nelson region, N. Foothills)	9.53 to 520.33	5.160 to 8.490
Fort Nelson, Helmet/Peggo segment (Fort Nelson region – NE section)	producer specific	2.542
Fort St. John (Plains-FSJ region)	54.29 to 283.25	7.645 to 19.529
Grizzly Valley (S. Foothills)	156.28 to 251.43	not reported

3.3 Future Capital Costs

As reservoir pressures decline, additional field compression will be required. See Capital Costs for investment information.

4.0 INFRASTRUCTURE

4.1 Overview

The main infrastructure requirements for constructing and operating facilities are transportation, energy, telecommunications and camps and support facilities.

Transportation

- BC and Alberta highways
- Secondary roads (logging, petroleum development)
- Temporary access, including winter roads
- Helicopter landing areas
- Commercial scheduled & chartered flights

Energy (gas/propane)

- On-site diesel generation (for camps)
- Fuel for transportation, field and central facilities etc.

Telecommunication

- Land lines
- Cellular service
- Satellite or radio-controlled SCADA (supervisory control and data acquisition)*
- VHF radio
- Computer

* These systems are for remote monitoring and controlling of well, pipeline and facilities operations.

Associated Businesses

- Repair and maintenance – vehicles and equipment
- Oilfield and industrial supplies and rentals
- Hauling, transport and hotshot services
- Trade and professional services
- Construction – access roads, leases, pipelines and surface facilities
- Operator services
- Laboratories - fluid testing
- Goods supply – camp provisions
- Safety, first aid, camp and catering services
- Accommodation in nearby centres (e.g., Fort St. John)

5.0 MARKET

- 2001 gas production was $29.9 \times 10^9 \text{ m}^3$ of natural gas and $2687 \times 10^3 \text{ m}^3$ of oil and natural gas liquids; $3.4 \times 10^9 \text{ m}^3$ of natural gas were imported, $15.3 \times 10^9 \text{ m}^3$ of natural gas were consumed within BC, injected into storage or used as fuel gas, $18.1 \times 10^9 \text{ m}^3$ of natural gas were exported
- $2.1 \times 10^9 \text{ m}^3$ and $7.1 \times 10^9 \text{ m}^3$ moved through the Alliance and TransCanada pipeline systems, respectively, to eastern markets in 2001. The Duke Energy natural gas receipt volume in 2001 was $24.3 \times 10^9 \text{ m}^3$, an increase of 21% over the $19.8 \times 10^9 \text{ m}^3$ received in 2000.
- Duke Energy is currently expanding the Southern Mainline (T-south) capacity by $2.1 \times 10^9 \text{ m}^3$ per year. This will allow additional natural gas deliveries from northeast B.C. to the lower mainland and the USA, to meet the growing demands of industrial, residential and power generation markets. The company is also expanding its capacity to import gas from Alberta, at Gordondale, to B.C., by $1,034 \times 10^6 \text{ m}^3$ per year. The anticipated in-service date for both expansions is November 1, 2003.

6.0 LABOUR FORCE

More than 32,000 people are working in the oil and gas industry in British Columbia. About 7,000 are actively engaged in exploration, production, development and related activities. The remaining 25,000 work in the downstream sector. Approximately 250 oil and gas service and production companies are working in the Northeast. Because Statistics Canada combines oil and gas labour figures with mining figures, it is difficult to break out numbers for oil and gas in most categories. In addition, some occupations are classified in general terms, based on their main activity (e.g., hauling gravel is under Transportation) and are not included under oil and gas statistics.

Labour requirements for constructing and operating gathering systems, gas processing plants and other facilities vary widely and cover a range of occupation codes. Following is a list of the major occupations associated with this part of the upstream oil and gas industry. Facility and production managers are also required (NOC Codes 720 and 811). Service workers under NOC group 62 (e.g., cook, kitchen helper) are also required at construction and permanent camps.

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NOC Code	Occupation	Skill Level	Skills	Wages* (\$/full year work)	Seasonality	Comments
2134, 2145	Chemical, Petroleum Engineer (project, specialist, mgr.)	A	University degree	\$70-100,000+	Year-round	Based at plant, in BC or Calgary
2154	Professional land surveyor	A	See above	Est. \$40-70,000	Primarily winter**	
Major groups 72, 73 (including 7352)	Trades, skilled transport and equipment operators (7352 covers battery operators)	B	Specialized training, work experience***	Est. \$40-60,000	Year-round; primarily winter for pipeline construction**	
Major group 74	Intermediate occupations (transport, equipment operators etc.)	C	Up to 2 yrs. on-the-job training, specialized courses etc.	Est. \$30-40,000	Primarily winter**	
7611	Construction trades helpers (pipeline)	D	Work demo. or on-the-job training	Est. \$25-35,000	Primarily winter**	
Major group 92	Supervisor, operator (gas processing plant)	B	See above***	Est. \$50-70,000	Year-round	

* Wages will vary widely depending on commodity prices, crew availability, location, work conditions etc. Therefore, with the exception of Codes 2134 and 2145 (based on the 2002 APEGGA salary survey), wages are estimated. The oil and gas industry typically pays higher than other industries because of winter, remote work conditions etc.

** May be year-round depending on where work is being conducted (i.e., in south or coastal areas).

*** Operators must also have safety, first-aid training.

7.0 CAPACITY

- Demand is driven by successful wells drilled, tested, proven and permitted for pipeline connection.
- An exploration and production company that owns a well typically constructs and owns the pipeline from the well to a central facility or gas plant.
- Duke Energy owns the three major gas plants in operation at Taylor, Fort Nelson and Pine River. Most gas plants built since market deregulation in 1985 are constructed, owned and operated by exploration and production companies that have extensive P&NG rights and well ownership in areas around the plants.
- The remaining reserve of 9 TCF indicates utilization of the current infrastructure can be expected for a minimum of 8 to 20 years. At current gas production rates, the current reserve could be produced out within 8.4 years. In fact, the current producing well rates decline and it may take over 20 years to produce out the current reserve.
- The Western Canada Basin resource potential of 50 TCF could be produced through the plant facilities currently in operation, thus utilization beyond the 8 to 20-year horizon is expected.
- Potential for expansion of the current infrastructure (i.e., in addition to expansion plans already in place) may occur if development of the gas resource is accelerated.
- Duke Energy owns and operates the major trunk line that transports gas from northeast B.C. to the Fraser Valley and the export point to the USA at Huntington.
- The Duke Energy system interconnects with the TransCanada-Alberta system at Gordondale, Alberta.
- The Alliance Pipeline connects B.C. gas at Aitken Creek and Fort St. John to Alberta and the Chicago market.

8.0 REGULATORY REGIME

8.1 Overview

This section summarizes the key local, provincial and federal regulatory requirements for constructing and operating gathering systems, gas processing plants and other oil and gas facilities. In addition to regulating these activities, provincial regulations are designed to address issues related to archeological sites, First Nations, fish and wildlife, forests, and watercourses. The regulations also attempt to minimize adverse effects on other commercial activities such as forestry, agriculture, the recreational use of land and transportation. Following is a list of acts that address many of these issues:

- *Petroleum and Natural Gas Act*, R.S.B.C. 1996, c. 361
- *Pipeline Act*, R.S.B.C. 1996, c. 364
- *Forest Act*, R.S.B.C. 1996, c. 157
- *Forest Practices Code of British Columbia Act*, R.S.B.C. 1996, c. 159
- *Heritage Conservation Act*, R.S.B.C. 1996, c. 187
- *Land Act*, R.S.B.C. 1996, c. 245

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- *Waste Management Act*, R.S.B.C. 1996, c. 482
- *Water Act*, R.S.B.C. 1996, c. 483
- *Wildlife Act*, R.S.B.C. 1996, c. 488

Note that subsurface rights are granted under the *Petroleum and Natural Gas Act*, while surface rights on Crown land are granted under the *Land Act*.

Pipeline and facility applications require plans for public consultation (including Emergency Response Plan consultation) and notification, as outlined in Section II of the Oil and Gas Commission's (the Commission's) *Public Involvement Guideline*. Landowners, occupants and residents must be consulted in most cases, while residents and local government authorities near a pipeline or facility must be notified of the program, depending on the location of the pipeline or facility and the nature of the gas.

8.2 Provincial

The lead agency that administers pipelines, gas plants and facilities is the Commission. Its mandate is to provide a single-window to review industry applications, grant surface land rights and ensure environmental economic and social impacts are addressed. The Ministry of Water, Land and Air Protection (MWLAP) and Ministry of Forests (MOF) may become involved if there are compliance- and enforcement-related issues regarding environmental damage and/or stream crossings (i.e., in reference to the *Water Act* and Forest Practices Code.) MWLAP is the primary agency that regulates the discharge of waste from facilities. If additional regulatory agencies should be involved in an application review, the Commission will notify the applicant.

Any company wanting to construct a facility or pipeline fully within British Columbia must submit a *Pipeline and Facility Engineering & Technical Review Package* and a *Facilities Engineering & Technical Review Package* to the Commission. A checklist for on-lease or off-lease facilities or pipelines on Crown or private land must accompany the applications to enable the Commission to ensure that the proposed pipeline complies with First Nations, public and legislative requirements. Supporting materials typically include an Application for Changes In and About a Stream and a Timber Harvesting and Field Assessment Application. Merchantable species must be utilized as directed in the Master Licence to Cut document and may not be disposed of by burning.

Environmental Assessment Act

A gas plant designed to process ≥ 200 Mmscf/d, and/or to emit 2 tonnes or more of sulphur per day is a "reviewable project" under the *Environmental Assessment Act*. Pipelines of diameter length dimensions greater than values specified under the Act are also reviewable. The Act also specifies the project review process and timelines.

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Private Land

- A lease or easement agreement is required to ensure that the owner (or land manager) has had an opportunity to review the proposal to identify potential conflicts and establish conditions to mitigate such conflicts. Proof of agreement is required before the Commission can issue Leave to Construct.
- If the access road will cross private lands, a landowner's agreement is requirement.
- The clearing of land and salvaging of timber must adhere to the requirements of the landowner.

First Nations

- The Commission's Aboriginal Relations and Land Use Branch coordinates field activities with First Nations and determines whether there will be potential treaty right infringements. Consultation is conducted with the band(s) claiming traditional rights in the area.

Note: If the land is within an Indian reserve, it is under federal jurisdiction and the Commission would not be involved.

Parks and Environmentally-Sensitive Areas

- Oil and gas activity is not allowed in parks in British Columbia
- Pipeline construction may be permitted on specified protected areas to allow production from wells drilled on existing tenures.
- Resource development is allowed on all Crown land outside parks, including "special management zones." In the Muskwa-Kechika Management Area in the North Foothills, pre-tenure plans precede posting tenure and drilling, to ensure that oil and gas development will be sensitive to important environmental and recreational values.

Regional Districts and Municipalities

Land use impacts and zoning conflicts are normally the main concern for local governments. This is especially true of sour gas developments where setbacks may apply to other types of developments around sour gas pipelines and facilities.

8.3 Federal Government

In addition to the acts listed below, the federal government is responsible for administering other acts, such as the *Migratory Birds Convention Act*, that may affect some oil and gas activity applications.

Navigable Waters Protection Act

- This Act regulates any activity in, around, under and over navigable waters, and is administered by the Canadian Coast Guard (CCG) of the Department of Fisheries and Oceans (DFO). Authorization under the Act is required for all stream crossings on navigable waters.

Fisheries Act

- Fisheries and Oceans Canada is responsible under the federal *Fisheries Act* to protect fish and fish habitat in "waters frequented by fish." For example, the Act prohibits the harmful alteration, disruption or destruction of fish habitat unless authorized by the Minister.
- By federal/provincial agreement, MWLAP is responsible for the management and protection of freshwater fish and anadromous fish stocks of steelhead, cutthroat trout, and Dolly Varden char.

Canadian Environmental Act

- The *Canadian Environmental Assessment Act* requires that environmental assessments be conducted for federal projects, projects involving federal funding, projects on federal lands and projects requiring a specific authorization or approval under specified sections of other federal acts.

8.4 Timing

The Commission tracks the timing of all applications and monitors the status of approvals from other provincial and federal bodies that are participating in the decision on a subject application. The review period for applications can range from a few days, if the proposed project is straightforward and in a developed area, to years, if it is in a sensitive and immature area.

9.0 GOVERNMENT REVENUES

The oil and gas industry is a major contributor to the economy, at all levels of government. The total provincial revenue from Crown royalties and reserve dispositions reached a peak in 2001 at over \$1.7 billion. (The number for 2002 is expected to be lower because of lower commodity prices.) Gas, processed products and oil royalties brought in over \$1.2 billion of the \$1.7 billion. In addition to these revenue streams, the industry produces many indirect sources of revenue through employment (and the collection of personal income tax) and the purchase of good and services within British Columbia.

Royalties on gas, gas by-products and oil are the major provincial revenue sources from the oil and gas industry. These payments are global in nature and not attributable to any one activity (e.g., geophysical exploration or drilling). Royalties are presented in this building block. Other revenue sources that are collected from gathering and processing systems and facilities are presented below.

Building Blocks for Economic Analysis

9.1 Municipal

- Business Licence Fees
 - Variable – depends on community; typically \$100/year)
- Room Tax
 - Some municipalities charge an additional accommodation tax of 2%.

9.2 Provincial

- Application Fees
 - \$100-500 (plus \$7.50/ha/yr) - lease
 - \$16,000 – gas processing plant; \$200 plus \$75/0.5 km of pipeline (min. \$350) – pipeline PL101; \$200 compressor/pump station PL103
 - In addition to fees under these fees, other fees for Water Act and Land Act applications are collected; these range from \$50 to \$250.
- Corporate Income Taxes
 - 13.5% of taxable corporate income.
- Employee Income Taxes
 - Based on the average wage level in BC for full time employment (\$32,000), a total of 22% is collected in federal and provincial personal income taxes. The Provincial tax component is typically 1/3 of this total.
- Levies
 - \$0.23/10³m³ – marketable gas levy; \$0.46/m³ – petroleum levy
- Motor Fuel Taxes
 - 7% of price if purchased; 1.1 cents per 810.32 L if used but not purchased) – stationary engines other than pipeline compressors (e.g., generators)
 - 1.9% cents per 810.32 L – stationary engines for marketable gas compression (i.e., at plant or compressor station)
- Petroleum and Natural Gas Rights
 - In 2001, \$59 million was collected from P&NG lease dispositions. Fees and rentals contributed an additional \$36 million. (Note: Tenure bonus amounts vary from competition to competition.)
- Property Tax
 - Based on assessed land value and “buildings”. Building values below a specified threshold (e.g., \$10,000) may be exempt. (“Buildings” may include structures, tanks, pipe, foundations etc.) The annual property taxes on a typical pipeline (e.g., 2 km, 88.9 mm diameter) are in the order of \$1000. This payment typically covers the provincial school tax, provincial rural tax and local service taxes. Local service taxes are paid to authorities (e.g., BC Assessment, Peace River infrastructure).
- Social Service Tax
 - Qualifying machinery and equipment used exclusively in the exploration, discovery or development of P&NG deposits are exempt.

Building Blocks for Economic Analysis

In addition to the revenue sources listed above, other provincial taxes, such as the accommodation tax of 8% (e.g., applied when industry employees stay in Fort St. John) and the provincial sales tax of 7.5% (on non-exempt goods), are collected as a result of oil and gas activity being conducted in British Columbia.

9.3 Crown Royalties

- Gas
 - price-sensitive when prices rise beyond a specified threshold
 - allowances for main access roads, gathering, dehydration and compression costs, processing and sales lines are deducted; 3rd-party tolls are also deductible
 - categorized as conservation gas (produced from an oil well) or non-conservation gas Base 9, 12 or 15 depending on when oil and gas rights were issued and when the well was spudded
 - gross royalty rate range for conservation gas is 8% to 12%; for non-conservation gas the range is 9% to 27%
- Gas By-products
 - based on "sales value" (consideration received less processing and transporting costs) or deemed value
 - royalty rate for NGLs is 20%; sulphur rate is 16.667%
- Oil – based on
 - monthly production volume
 - date the pool was discovered (i.e., old, new, third tier oil)
 - oil grade (i.e., light or heavy)
 - average sales price received by the producer
 - clean oil trucking costs are deductible
 - gross royalty rate range is from 1 to 37%

Note: The Province has entered into 50%-50% revenue sharing agreements with several Indian bands in northeast B.C. These agreements provide for the equal sharing of P&NG tenure disposition bonuses and rental payments and royalties derived from the bands' reserves.

9.4 Federal

- Employee Income Taxes; Federal personal income tax is typically 2/3 of the total personal income tax collected.
- 26.12 % of taxable corporate income (i.e., for the average wage level).
- The federal sales tax is 7.0% and is charged on all goods and services.

10.0 INPUT-OUTPUT TABLE

The following table, based on 2001 data, summarizes the costs and revenue streams associated with producing gas in B.C. (Oil production is not illustrated here since gas production far exceeds oil production in the Province). Cost, revenue and production streams were discounted at 10% to determine unit costs (i.e., \$/mcf). Provincial burdens and federal tax were relatively high because of high commodity prices.

Input costs in all categories have been increasing in the last five years, while pool sizes and average deliverability rates have been declining. Gas pools discovered from 1996 to 2001 ranged from 4 to 11 BCF in the Plains-Fort St. John region, from 4 to 18 BCF in the Fort Nelson region and from 19 to 28 BCF in the Foothills.

Region	Input (\$/mcf)*								Output (\$/mcf)		
	Bonus/ rental Cost	Geo. Explor.	Drillin g Cost	Operating/ gathering cost	Processing cost	Provincial Royalties & Tax	Federal Tax	Input/ Pool (\$million/ pool)	Gas Rev.	Liquids Rev.	Net Rev.
Plains-FSJ	0.04- 0.37**	0.01- 0.16	0.37- 0.92	0.25-1.03	0.18-0.60	0.91-1.06	0.34- 0.52	15-35	3.58- 3.85	0.09- 0.51	0.45-0.78
Deep Basin	0.13	0.08	1.55	0.43	0.22	0.88	0.29	32	3.74	0.03	0.24
Fort Nelson	0.11- 0.23	0.04- 0.14	0.61- 0.87	0.46-0.54	0.40-0.64	0.90-0.94	0.26- 0.38	13-57	3.59- 3.68	0.01- 0.09	0.33-0.52
Foothills (N)	0.10	0.06	1.12	0.67	0.44	0.92	0.28	68	3.71	0.12	0.25
Foothills (S)	0.10	0.13	0.72	0.50	1.24	0.69	0.19	100	3.76	-	0.18

* Costs are to plant exit only. Transmission tolls are not listed.

**Costs for south FSJ were exceptionally high. Bonus/rental costs in most areas within the Plains-FSJ region were around \$0.20/mcf.

11.0 REGIONAL COST VARIATIONS

11.1 Regions

British Columbia has resource regions located throughout much of the Province. Northeast B.C. has been the primary focus of oil and gas exploration and development for over 50 years. There are three main regions in the northeast – Plains-Fort St. John, Fort Nelson, Foothills (trending northwest from Pine River to the Muskwa-Kechika). These are associated with the Western Canada Sedimentary Basin (WCSB). Other basins in the Province are considered immature basins. The figure “British Columbia’s Energy Resources,” which can be found on the Ministry of Energy and Mines website at http://www.em.gov.bc.ca/dl/Oilgas/FuelingFuture/OGCBMmap_panel.jpg, shows the locations of the Western Canada Sedimentary Basin and immature basins.

11.2 Regional Data

Regional differences have been addressed in each building block if costs and other data were available. Where appropriate, the Deep Basin has been separated from the remainder of the Plains-Fort St. John region because of significant differences in pool depths and costs to develop these. In some tables, the Foothills region has been divided into north and south areas. Wells in the south are deeper, highly sour and more costly to develop than wells in the north. Data for immature basins is either very limited or non-existent, due to the complete lack of industry and system infrastructure in some of these basins. In particular, the costs to explore and develop oil and gas resources in the Whitehorse Trough and the Bowser Basin may be double those encountered in the South Foothills. Costs could also be high in basins in the south part of the Province, such as the Georgia Basin, where planning requirements and review periods are extensive.

11.3 Pre-tenure Planning

Pre-tenure plans are being developed by the Ministry of Sustainable Resource Management for the Muskwa-Kechika Management Area in the North Foothills region. These plans must be in place before tenures can be made available in special management zones within the management area. Plans identify sensitive resource values and objectives and strategies to support environmentally responsible development. Resource values include recreational, mineral and geothermal values, as well as environmental values.

The Foothills region has high wilderness and wildlife values but due to the relatively harsh climate conditions in the region, is more sensitive to oil and gas development than the Plains-Fort St. John and Fort Nelson regions. The same is true for many of the immature basins, which are also in mountainous areas.

11.4 Evolution of Immature Basins to Mature Producing Regions

Immature basins are areas of the province in which government or industry geologists have identified the potential oil or gas resources but there is limited drilling, minimal production and very little pipeline infrastructure. The area is first explored by geophysical operations that determine subsurface structure by recording the reflection of sound waves. If the geophysical review of seismic data indicates a structure that could trap oil or natural gas, wells will be proposed to test the subsurface interpretation. Initial wells have a high degree of failure; only one well in ten to twenty wells may be productive.

Once a number of wells are deemed to be productive, the first pipeline infrastructure is built. This infrastructure is an important step in the maturation of a basin. The first successful wells prompt additional wells; the first pipelines promote new geological investigations of potential fields in proximity to the pipelines. The presence of pipelines improves exploration economics and promotes additional geophysical exploration and drilling. This leads to production success, which in turn reduces the operating costs of the infrastructure. The reduction in transportation fees promotes a higher level of exploration, resulting in a more mature basin. As geology is better understood, infill wells (wells located between existing wells) are drilled to recover additional reserves and accelerate production.

Building Blocks for Economic Analysis

The life of a typical pool can vary in any region, from as few as five years, if water inflow problems occur, to over 30 years. To fully deplete gas pools and maintain production as the reservoir pressure declines, wells may be worked over (stimulated) and compression can be added. Oil wells can also be worked over to optimize production rates. The recovery of oil reserves can be enhanced by injecting water or carbon dioxide to maintain the reservoir pressure as oil is produced.

In the passage of 20 to 60+ years, the basin reserves are produced and depleted.

Immature basin development is influenced by a variety of factors including the:

- location of overlying parks
- ease of access into the areas
- proximity to existing infrastructure
- availability of corridors for infrastructure (e.g., pipelines)
- North American demand for gas supplies

Opportunities and challenges companies may face when exploring and developing immature basins, and currently undeveloped fields in the WCSB, are listed below.

11.5 Opportunities

- Significant untapped potential in Foothills, immature basins
- Strong demand – electric generation in the U.S., industrial and residential markets
- Transmission pipeline capacity
- Advances in technology for 3D(4D) seismic, drilling techniques etc.

11.6 Challenges

- Need to replace production as fields in Plains-Fort St. John, Fort Nelson mature
- Lengthy approval process in the Foothills (and immature basins)
- Land use restrictions prevent multiple underlying zones from being developed
- Volatile commodity prices
- Rising exploration and development costs
- Smaller pools, high decline rates
- Need to drill deeper plays in undeveloped areas with a shorter drilling season
- Higher hydrogen sulphide concentrations in deeper plays in Foothills
- Gas plant constraints for sour gas
- Competition from other jurisdictions
- Kyoto Accord

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